APPLICATION OF ACOUSTIC TELEMETRY TAGS ON SNOW CRAB

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2016

Canadian Technical Report of Fisheries and Aquatic Sciences 3169

Fisheries and Oceans Canada | Pêches et Océans Canada

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Canadian Technical Report of Fisheries and Aquatic Sciences

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© Her Majesty the Queen in Right of Canada, 2016.
Cat. No. Fs97-6/3169E-PDF ISBN 978-0-660-05636-4 ISSN 1488-5379

Correct citation for this publication:

Zisserson, B. & Cameron, B. 2016. Application of Acoustic Telemetry Tags on Snow Crab. Can. Tech. Rep. Fish. Aquat. Sci. 3169: v + 17 p.

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ABSTRACT

Zisserson, B. & Cameron, B. 2016. Application of Acoustic Telemetry Tags on Snow Crab. Can. Tech. Rep. Fish. Aquat. Sci. 3169: v + 17 p.

Tagging of snow crab has long been used as a method of tracking animal movement. The majority of this tagging has occurred with the use of external ("spaghetti") tags which require recapture of the tagged individual to determine the tag number and only provide information on the points of mark and recapture not on the intervening movements. Since 2013, snow crab have been tagged on the Scotian Shelf with the use of acoustic transmitting tags, allowing for remote tracking of these animals through existing acoustic receiver arrays. These tags are attached to the crab using both polyether tubing and a marine adhesive. Biological and geographic data for these tagged animals are stored with the Ocean Tracking Network to facilitate potential sharing of this data with other acoustic tracking projects. A detailed description of this novel tagging methodology and associated data management are provided within this document.

RÉSUMÉ

Zisserson, B. & Cameron, B. 2016. Application d'étiquette télémétrique acoustique au crabe des neiges. Rapp. Tech. can. Sci. halieut. Aquat. 3169: v + 17 p.

Historiquement, le marquage du crabe des neiges a été utilisé afin de suivre leur mouvement. La majorité des études sur le marquage a été faite en utilisant des étiquettes appliquées sur l'extérieure du crabe (le type spaghetti), ce qui nécessite la recapture des crabes pour déterminer le numéro de l'étiquette et le suivi de leur déplacement. Depuis 2013, une nouvelle étiquette acoustique a été introduite pour le marquage du crabe des neiges dans la région du plateau néo-écossais ce qui permet de suivre leur mouvement à l'aide d'une série de receveurs acoustiques installés sur le fond de l'océan. Ces étiquettes sont attachées sur le crabe en utilisant un tube de polyéther et de l'adhésif. Des données biologiques et géographiques provenant des crabes étiquetés sont enregistrées avec le 'Réseau de Suivi Océanique' afin de faciliter le partage de ces données avec d'autres projets de suivi acoustique. La description détaillée de cette nouvelle méthodologie ainsi que la gestion des données associées sont fournies dans ce document.

INTRODUCTION

The snow crab (*Chionoecetes opilio*, Brachyura, Majidae, O. Fabricius) is a subarctic crustacean species found along the continental shelf of both the Pacific and Atlantic oceans. The Atlantic distribution now extends from the Gulf of Maine to the Barents Sea. On the Scotian Shelf (Figure 1), snow crab inhabit a wide range of depths (60 to 280m) and bottom types. Soft, small substrate bottom types are generally preferred as are relatively cold (-1 to 6 ^{0}C) waters.

Marked-recapture studies are a common method to determine the movement of individual animals of various species. The life history of the studied species is always a consideration in designing such studies. Snow crab moult throughout their lives until reaching a terminal moult, when moulting ceases. This terminal moult is accompanied by changes in the animal's morpohology that allow for easy visual determination of terminal moult status. These "morphometrically mature" animals are almost always sexually mature (Conan & Comeau, 1986). Terminal moult status of an animal must be considered for tagging methodology and tag type selection. Some tagging methods may physically prevent moulting (and cause death of the tagged crab). Tag retention time is affected by the crab's life stage; animals not yet terminally moulted will generally have tag retention times less than one year whereas terminally moulted animals will have potential tag retention times of one to six years. The potential retention time of a tag must be considered in determining exact tag specifications.

Such movement studies have been carried out on snow crab stocks within Atlantic Canada since the early 1990's (Biron et al., 2008) with the use of uniquely numbered, spaghetti-type tags (Figure 2). In excess of 25,000 of these tags have been applied to snow crab in the Gulf of St. Lawrence and on the Scotian Shelf (Biron et al, 2008; Choi et al, 2012), both commercially important snow crab fishing grounds. Other types of snow crab tags (T-bar and magnetic) have also been tested without particular success (Hurley et al, 1990) along with a very limited (<10 animal) application of ultrasonic (acoustic) tags (Maynard and Robichaud, 1986; Maynard and Webber, 1987).

In 2013, a modest (27 animal) acoustic tagging project (Cook et al. 2014) was started to re-examine the potential use of acoustic tags (Figure 3) to track the movement of snow crab through an existing array of acoustic receivers. This project has grown in subsequent years. An important aspect of project success was the determination of a best methodology for tag attachment to ensure that tags were able to remain attached to the host animal for up to 5 years, the approximate maximum battery life of the tag. The specifications for the acoustic tags used are shown in Table 1.

This document outlines the methodology developed through this initial project and subsequent projects.

MATERIALS

TAGGING

- Acoustic tags fitted with end caps.
- "Spaghetti" tags- Texin®987U Polyether tubing with printed discs and Nicopress™ sleeves
- Additional polyether tubing and/or thin non-corrosion resistant wire
- Shop towels or other material to dry crab carapace
- Cordless rotary tool (i.e. Dremel™)
- Nylon brush for rotary tool (Dremel™ part # 538)
- 3M™ 5200 fast cure marine adhesive
- Diagonal cutters (often referred to as side cutters)
- 200mm digital callipers (modified jaws)
- OTN field sheet (data deck sheet)

CRAB CAPTURE, HOLDING AND RELEASE

- Traps for animal capture, commercial or modified depending on target animal size and sex
- Trap rigging (ropes, buoys, bait bags, bait, etc.)
- Large insulated storage box (used as holding tank)
- Porous vessel within the holding tank to contain crab
- Salt ice or other cooling method
- Aerator or water circulation system
- Release cage
- GPS

ELECTRONIC DATA MANAGMENT

- Microsoft Excel or Excel capable alternative
- Ocean Tracking Network member account (http://oceantrackingnetwork.org/join-otn/)
- Metadata Excel sheet

METHODS

TAG PREPARATION AND STORAGE

A spaghetti tag is placed through the end cap on each acoustic tag, generally a Vemco® V13 for mature male crab. The disk (Figure 4) on the spaghetti tag is printed with the following information:

- Unique identification number (linked to the acoustic tag number which is not visually apparent on the acoustic tag)

- Notice to return crab to water ASAP if caught during commercial fishing efforts
- Phone number to call to report the date and time of the tag recapture

The surface of the acoustic tag is lightly sanded to ensure maximum adhesion to the crab carapace.

These paired tags (one spaghetti, one acoustic) are then stretched over a plastic board to ensure that the tags are stored in a manner to ensure fast and orderly tag application. Between each pair, an additional spaghetti tag without a disc is placed. This will be used to secure the acoustic tag (further details in tagging section below).

ANIMAL CAPTURE

All precautions are taken to ensure the highest possible animal health and survival rate as the tag costs (and associated application costs) are much higher with acoustic tags than with conventional (i.e. spaghetti) tags. A research notice (scientific fishing permit) is maintained throughout the course of all animal capture and subsequent release (Appendix 1). This research notice (scientific fishing license) defines the scope of the work and is issued by the Department of Fisheries and Oceans.

Baited traps are set to capture crab in target locations. Standard commercial crab traps are used to capture terminally moulted male crab. These commercial traps are top entrance, metal frame strung with poly netting, conical traps of 6-7' diameter (Figure 5). For other segments of the snow crab population, namely female and juvenile males, modified shrimp traps are used. These shrimp traps are a top entrance rectangular trap constructed of small-meshed plastic coated wire (Figure 6).

All efforts are made to ensure that animals are caught in the location where they are to be released. Proximal capture and release locations minimize potential unnatural behaviour patterns being introduced by changes in habitat / environment. These traps are generally set for shorter time intervals (12-24 hours) than the standard for commercial fishing efforts. The shorter "soak time" aims to reduce physical damage caused by over-crowding, entanglement or restricted foraging ability by trapped crab. These traps are hauled and crab are removed manually from the trap rather than dropping crab from trap as is common commercial fishing practice. Crab are inspected and any crab showing physical damage or signs of decreased health or viability are returned to water untagged.

ANIMAL HOLDING

A holding tank (850 litre) is set up on the vessel deck to prepare for holding animals before tagging. This tank is filled with surface seawater. If ambient sea surface temperatures are above 5-7°C, or air temperatures are warm (>~15°C), two blocks of

salt ice (approximately 50 litres each) are added to the water. If few animals will be held / tagged, a smaller tank is sometimes used with a single ice block. These blocks are fastened to the bottom of the holding tank to ensure that the crab are not physically impacted by shifting blocks of ice. A water recirculation system ensures proper oxygenation and protects against thermal stratification. The crab are stored in a containment vessel on the top of the containment tank which allows unrestricted water flow but protects the crab from the ice and recirculation equipment. This holding box within the larger tank is covered to reduce exposure to light. Crab are then removed individually for tagging.

TAGGING

Upon removal from the holding tank, each crab is inspected again to ensure that there are no signs of physical damage which could result in decreased viability of the animal. If deemed healthy, the animal is placed on a flat surface to support the legs. There is an indentation in the center of the crab's carapace (Figure 7a). This provides an ideal location for placement of the acoustic tag. The carapace proximal to this location is dried using Scott® shop towels. The shell is then lightly abraded with a light abrasive brush fitted on a rotary tool (Figure 7b). Specifically, a Dremel® rotary tool with a #538 abrasive brush has been used. This brush serves to further dry the carapace as well as removing any epibiont growth on the carapace service. This preparation creates a clean, dry surface that is rougher than a normal crab carapace and aids in tag adhesion.

The spaghetti tag attached to end cap of the acoustic tag is placed around the animal's carapace between the second and third walking leg. A small volume, approximately 4cm^2, of 3M® 5200 marine is then placed on the carapace in this central indentation (Figure 7c). The end cap of the tag is pressed into the adhesive (Figure 7d). The non-capped end of the acoustic tag contains the transmitter so it must not be mounted in adhesive as it could potentially impact or limit acoustic transmission. Once the acoustic tag has been mounted in the adhesive, the spaghetti tag is tightened and the Nicopress™ sleeve is crimped (whatever it is called), and excess tubing removed (Figure 7e). This spaghetti tag maintains the acoustic tag in contact with the adhesive until the adhesive has completed cured. An additional piece of polyether tubing is tightened and crimped in a similar manner around the carapace and posterior portion of the acoustic tag to further ensure proper tag positioning throughout curing. This curing process takes ~24 hours but will occur completed while submerged in sea water.

One necessary consideration is the life stage of the animal being tagged. Animals not terminally moulted (Choi et al., 2005) will shed their carapace (and any attached tags) at their next moult. A spaghetti tag around the animal's carapace will prevent moulting and ultimately result in the death of the animal. For non-terminally moulted animals, thin ferrous wire can be substituted for the polyether tubing (e.g. "pipe cleaner", J. Broome, pers. Comm.). This wire will secure the tag throughout adhesive curing but will corrode and detach, allowing the animal to moult successfully (Figure 7f), though

the tag will be lost with the discarded carapace. For these smaller, non-terminally moulted animals, smaller tags can be used, such as a Vemco® V9. These tags have identical programming to the larger tags used on terminally moulted animals but have decreased detection range and life-span due to smaller internal batteries.

Once tagged, animals are generally placed back in the holding tank as multiple (3-8) tagged crab are usually released together. This additional holding time (post-tagging) also allows for further visual assessment of animal health and tag placement. If either of these factors is compromised, the tag can be reattached or removed and placed on another animal.

ANIMAL RELEASE

A release cage (Figure 8) has been designed to facilitate the release of tagged animals. This cage is 92 cm (length) x 62 cm (width) x 18 cm (height) and is constructed of 1.5" (3.8 cm) plastic coated wire mesh. The bottom and sides of the cage are lined with a fine plastic mesh to protect the crab from injuries caused by leg protrusion. Two weights are attached inside the cage to aid in its lowering to the seafloor.

When ready for release, crab are carefully transferred from the containment tank to the release cage, ensuring that the newly attached transmitters are not moved. If any transmitters have shifted, they are re-oriented and inspected to ensure proper adhesion.

The release cage is lowered slowly to the sea floor at the desired release location. Position, date and time are recorded. Upon bottom contact, a release mechanism is activated to open the release cage. The open cage is then maintained in this position on the seafloor for ~5 minutes to allow the tagged animals to exit. This method of release minimizes potential pelagic drift of the animals during settlement and protects them from predation throughout the water column.

DATA MANAGEMENT

NON-ELECTRONIC DATA

The Ocean Tracing Network (OTN, http://www.oceantrackingnetwork.org) provides a data repository for acoustic telemetry data from numerous projects throughout the world. OTN is able to facilitate the sharing of transmitter detection data between projects, increasing the potential detections of any tagged animals. OTN provides standard paperwork (http://members.oceantrack.org/data/data-collection/data-sheet-templates) to capture required data for any project which ensures that standards are maintained across projects.

The OTN field sheet (http://members.oceantrack.org/data/data-collection/data-sheet-templates/otn-tagging-fieldsheet/view, Appendix 2) facilitates the recording of transmitter (acoustic tag) release data at sea. It is optimized for marine vertebrate

tagging but is readily adapted for use with invertebrates such as snow crab. One field sheet is completed for each release event. Capture location and time is not typically recorded as the animals are captured as near to the release locations as possible. The OTN data dictionary (http://members.oceantrack.org/groups/otnhq-headquarters-operations/OTNDC/2008/DATA_DICTV1.2.doc/view) provides necessary details and standards for each data field in all OTN paperwork / forms.

For male snow crab, carapace width and claw height are measured using digital callipers to the nearest millimeter. These values are entered in the Length and Length2 columns. The length types are entered as "CarapaceW" and "ClawH" respectively.

For female snow crab, carapace width and abdomen width are measured using digital calipers to the nearest millimeter. These values are entered in the Length and Length2 columns. The length types are entered as "CarapaceW" and "AbdomenW" respectively.

Individual weights are not taken. Carapace Condition (Table 1) is considered to be a relative measure of time since the last moult (Choi et al., 2005). As such, this is evaluated (1-5) and entered in the age column. The sex is recorded with M (male) or F (female). Durometer reading, a measurement of carapace hardness, is entered in the comments column along with any other points of interest associated with a particular animal. Holding tank temperature, if available, is placed in the surgery details section.

All completed paper forms are photographed immediately upon completion to provide an electronic back-up.

ELECTRONIC DATA

An electronic data entry sheet is also provided by the Ocean Tracking Network (http://members.oceantrack.org/data/data-collection/data-sheet-templates/otn_metadata_tagging.xls/at_download/file, Appendix 3). The completed deck sheets are used to fill out the majority of this data sheet. Required tag specifications are found in documentation accompanying acoustic tags from the manufacturer. When complete, the electronic data sheet is submitted to OTN (otndc@dal.ca). OTN data managers load this data to a private project data repository. Access to this repository is controlled by the project lead. Local copies also remain resident on DFO computers. This allows for visual data checks and edits to be performed while also serving as a data backup. The private OTN project data repository also contains detection data when these tagged animals encounter acoustic receivers subsequent to tagging and release.

ACKNOWLEDGEMENTS

The authors wish to thank Adam Cook for his assistance in developing this tagging technique. Additional testing of this technique was completed by David Coté

and Jeremy Broome. The application of acoustic tags on snow crab would never have developed and continued without financial and operational support from the snow crab industry in crab fishing area (CFA) N-ENS.

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TABLES

Table 1. Tag specifications

Animal Type	Tag Family	Est tag life (days)	Step 1 Status	Step 1 Time (dy hr:min:sec)	Step 1 Power (L/H)	Step 1 Min Delay (sec)	Step 1 Max Delay (sec)	Step 2 Status	Step 3 Status
Immature / Female	V9-2x-069k-3	890	ON	895 00:00:00	H	350	450	OFF	OFF
Mature Male	V13-1x-069k-3	1586	ON	1591 00:00:00	H	350	450	OFF	OFF

Table 2. Snow crab carapace conditions

Carapace condition	Category	Hardness	Description	Age after terminal moult (approximate)
1	New soft	< 68	claws easily bent, carapace soft, brightly coloured, iridescent, no epibionts	0 - 5 months
2	Clean	variable	claws easily bent, carapace soft, brightly coloured, iridescent, some epibionts	5 months - 1 year
3	Intermediate	> 68	carapace hard, dull brown dorsally, yellow-brown ventrally, no iridescence, shell abrasion, epibionts	8 months - 3 years
4	Old	> 68	carapace hard, very dirty, some decay at leg joints, some epibionts	2 - 5 years
5	Very old	variable	carapace softening, very dirty, extensive decay, extensive epibionts	4 - 6 years

FIGURES

Figure 1- Scotian Shelf with snow crab fishing areas (CFA's)

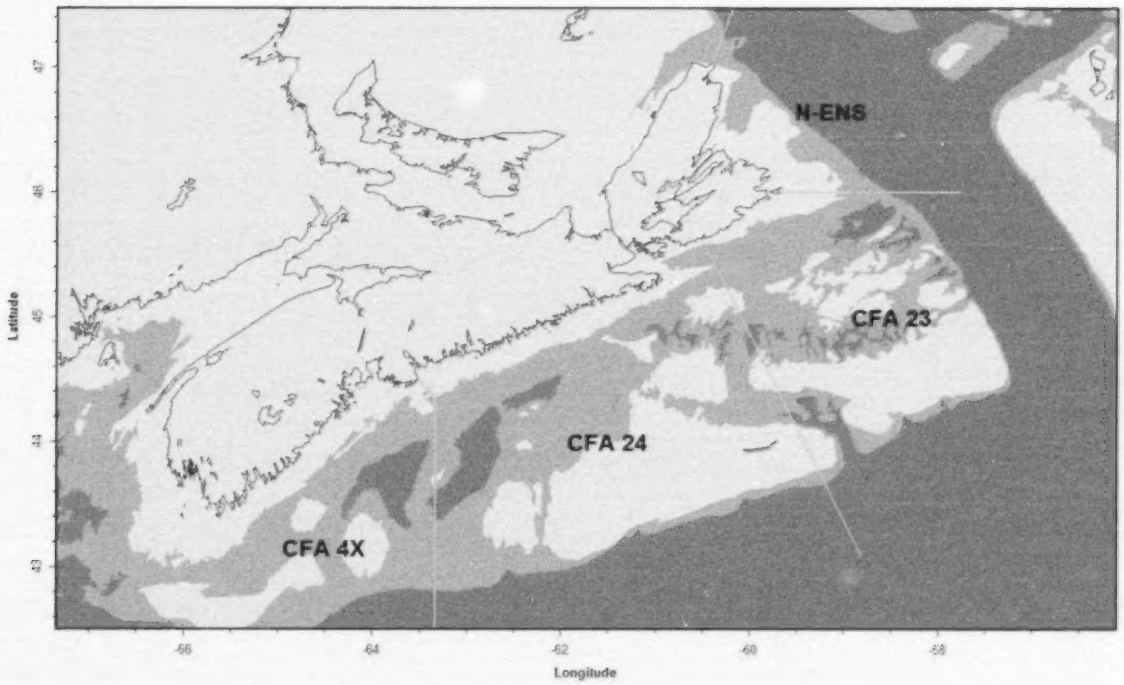


Figure 2- Spaghetti tag on snow crab

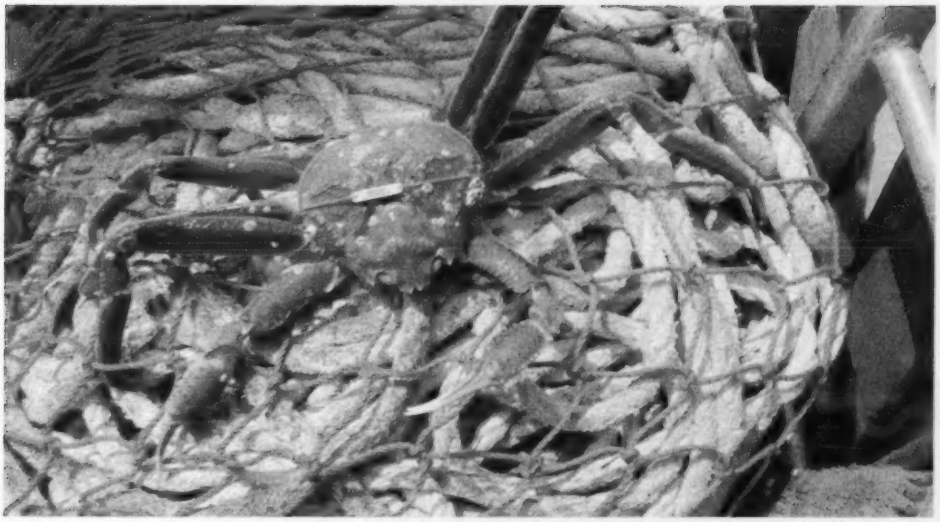


Figure 3. Acoustic tagging pilot project map

Figure 4- Tag information disk attached to tubing on acoustic tag

Figure 5. Snow crab trap for capture of mature male snow crab.

Figure 6. Modified shrimp trap for capture of female and immature snow crab.

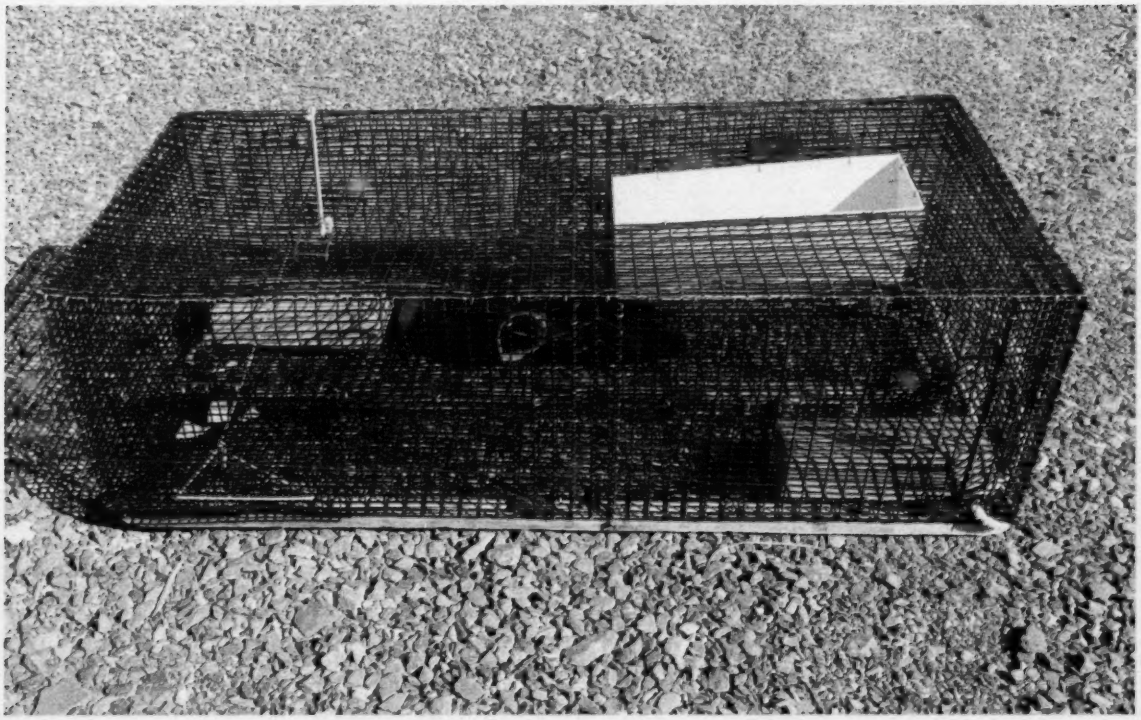


Figure 7. Acoustic tag application procedure for snow crab.

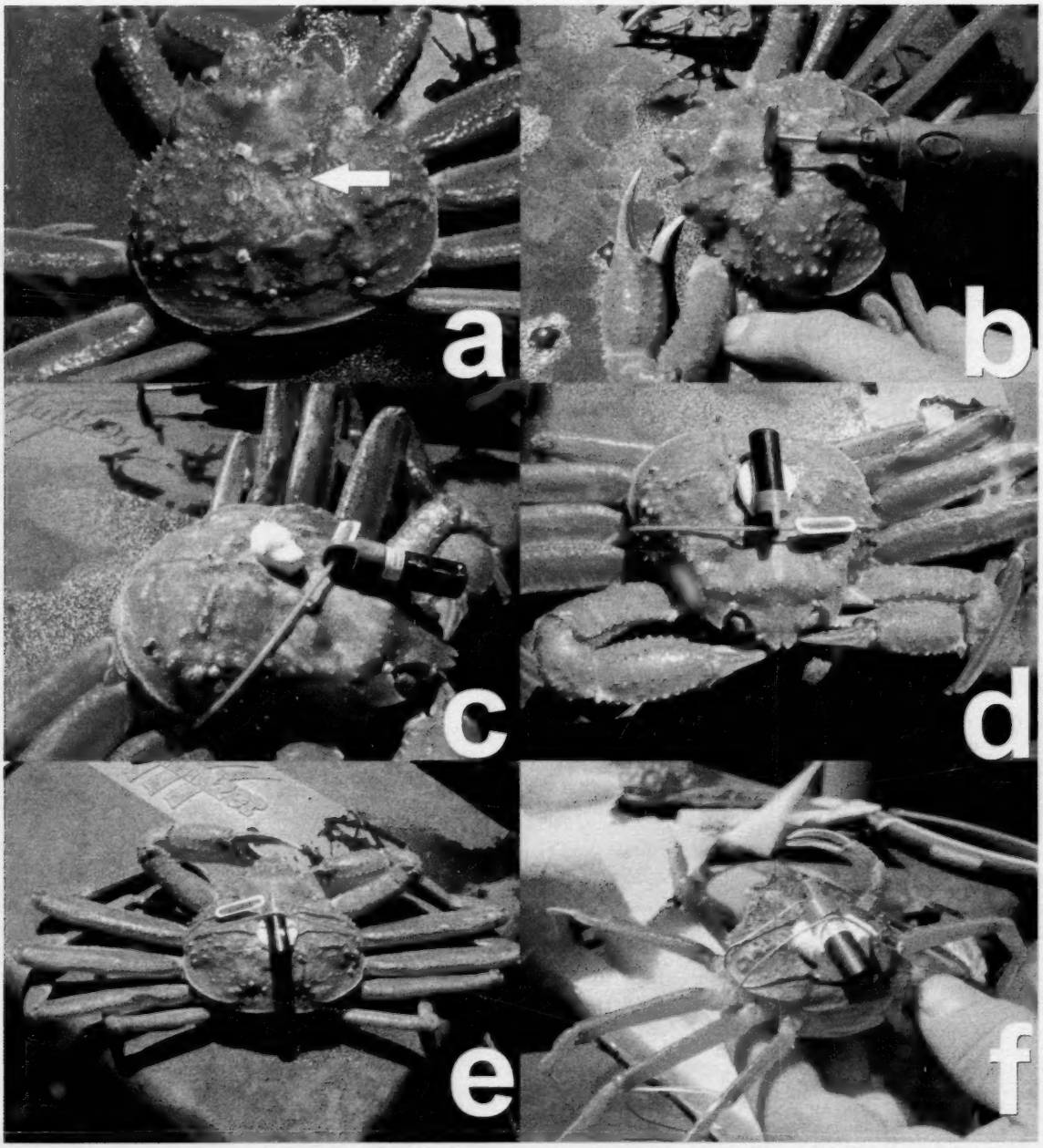
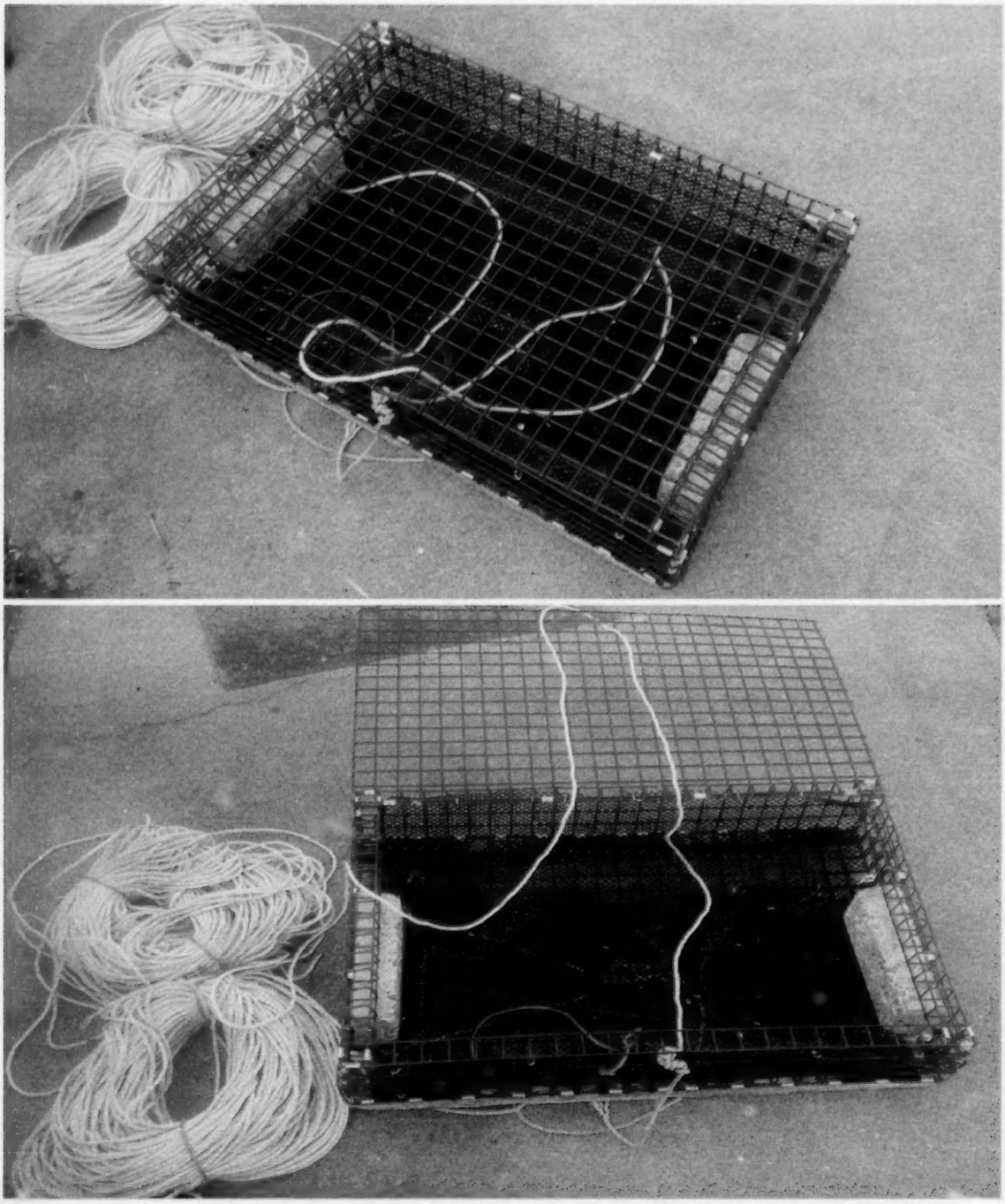


Figure 8- Release cage for tagged animals



APPENDICES

Appendix 1. Fisheries research notice

Fisheries and Oceans Canada / Pêches et Océans Canada — Canada

Maritimes Region | Région des Maritimes

Fisheries Research Notice

Number: M-15 -

Title: Snow Crab Tagging

Duration (starting and ending dates): August 5, 2015 *(start)* — August 15, 2015 *(end)*

City of Departure and Return (Vessel or aircraft): Port Morien *(departure)* — Port Morien *(return)*

Vessel Name: F/V Crab Fisher

Officer In Charge (OIC): Brent Cameron

Name of License Holder
(if different from above):

Scientific Staff: Brent Cameron and DFO contractor (observer)

Fishing Gear used (size and mesh - describe): Conical Snow Crab Traps

Expected Catch: Snow Crab *Species* — Various *Amounts*

Will Fish be Retained? ☐ YES X☐ NO
If YES, how will the fish be disposed of after the project is complete?

Area of Work: Glace Bay Hole Crab Area (N-ENS)

Objectives: Tagging of commercial snow crab for movement studies

Responsible Officer: Ben Zisserson Date : August 4, 2015

Approval / Approbation: Date: _____

Name: Alain F. Vézina
Regional Director, Science
Science Branch
Maritimes Region

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April 2015

Appendix 2. Deck data sheet

OCEAN TRACKING NETWORK

TAGGING METADATA FIELDSHEET version 2.0

PLEASE SUBMIT ALL DATA VIA EMAIL TO THE OTN DATA CENTRE: otndc@Dal.Ca

The GREEN SHADED fields are mandatory.

See Data Dictionary sheet for a detailed description of each field.

TAGGER		TAG_OWNER_PI		TAG_OWNER_ORGANIZATION	
COMMON_NAME_E		CAPTURE_LOCATION		RELEASE_LOCATION	
SCIENTIFIC_NAME		CAPTURE_LATITUDE		RELEASE_LATITUDE	
WILD_OR_HATCHERY		CAPTURE_LONGITUDE		RELEASE_LONGITUDE	
STOCK		CAPTURE_DEPTH (m)		UTC_RELEASE_DATE_TIME	

TAG_SERIAL_NUMBER	ANIMAL_ID	LENGTH (m)	LENGTH_TYPE	LENGTH2 (m)	LENGTH2_TYPE	WEIGHT (kg)	AGE	SEX	DNA_SAMPLE_TAKEN	TREATMENT_TYPE	RELEASE_GROUP	COMMENTS

Surgery details (optional)

TEMPERATURE_CHANGE (degrees C)		SEDATIVE	
HOLDING_TEMPERATURE (degrees C)		SEDATIVE_CONCENTRATION (ppm)	
PREOP_HOLDING_PERIOD		ANAESTHETIC	
POSTOP_HOLDING_PERIOD		BUFFER	
SURGERY_LOCATION		ANAESTHETIC_CONCENTRATION (ppm)	
DATE_OF_SURGERY		BUFFER_CONCENTRATION_IN_ANAESTHETIC (ppm)	
SURGERY_LATITUDE		ANAESTHETIC_CONCENTRATION_IN_RECIRCULATION (ppm)	
SURGERY_LONGITUDE		BUFFER_CONCENTRATION_IN_RECIRCULATION (ppm)	
		DISSOLVED_OXYGEN (ppm)	

All dates and times are to be recorded in UTC 24-hour format.

All latitudes and longitudes should reference the WGS84 map datum.

For help with this form, please contact the OTN Data Centre: otndc@Dal.Ca or 1-902-494-8470.

Appendix 3. Electronic data submission form

| OCEAN TRACKING NETWORK | TAGGING METADATA | PLEASE SUBMIT THIS DATA SHEET VIA EMAIL TO THE OTN DATA CENTRE: otndc@Dal.Ca | | |